



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
8604 La Jolla Shores Drive
La Jolla, California 92038

15 April, 2004

FINAL CRUISE REPORT

VESSEL: NOAA Ship *David Starr Jordan*

CRUISE NUMBERS: OMAO cruise number DS-03-06 and SWFSC Marine Mammal Cruise Number 1624

CRUISE DATES: 31 July – 10 December 2003

PROJECT: *Stenella* Abundance Research Project (STAR)

SPONSOR: NOAA, NMFS, Southwest Fisheries Science Center (SWFSC)
Protected Resources Division (PRD)

CHIEF SCIENTIST: Dr. Lisa T. Ballance, SWFSC (858) 546-7173, Lisa.Ballance@noaa.gov

ITINERARY:

LEG 1: 31 JUL- Depart San Diego, CA	17 AUG- Arrive Manzanillo, Mexico
LEG 2: 20 AUG- Depart Manzanillo	7 SEP- Arrive Acapulco, Mexico
LEG 3: 17 SEP- Depart Acapulco	30 SEP- Arrive Puntarenas, Costa Rica
LEG 4: 7 OCT- Depart Puntarenas	24 OCT- Arrive San Jose, Guatemala
LEG 5: 28 OCT- Depart San Jose	18 NOV- Arrive Manzanillo, Mexico
LEG 6: 22 NOV- Depart Manzanillo	10 DEC- Arrive San Diego, CA

CRUISE DESCRIPTION AND OBJECTIVES: The primary objective of the *Stenella* Abundance Research cruise is to investigate trends in population size of those dolphin stocks most affected by the eastern tropical Pacific tuna purse-seine fishery. The STAR project takes a multidisciplinary approach. Data on cetacean distribution, school size and school composition are collected to determine dolphin abundance. Oceanographic data are collected to characterize habitat and its variation over time. Data on distribution and abundance of seabirds, flyingfish, and marine turtles will further characterize the ecosystem in which these dolphins live. Photographs of dolphin schools taken from a helicopter indicate school size, proportion of calves, and school structure. Skin biopsies of cetaceans provide a database for investigations of stock structure and phylogenetic relationships. Photographs document geographic variation in dolphins, and distribution of individual large whales.

The STAR 2003 cruise was a two ship project. Activities of the other vessel, NOAA Ship *McArthur II*, are covered in a separate report.



STUDY AREA:

The eastern tropical Pacific Ocean (ETP). Tracklines covered are shown in **Figure 1**.

1.0 PROCEDURES FOR DAYLIGHT OPERATIONS

1.1 Cetacean Survey - Line-transect survey methods were used to collect abundance data. At the beginning of each day search effort started on the trackline. The *Jordan* travelled at 10 knots (through the water) along the designated trackline. While on search effort, if the ship's speed through the water deviated from this by more than one knot, the bridge personnel notified the mammal team on watch or the Cruise Leader. A daily watch for cetaceans was maintained on the flying bridge during daylight hours (approximately 0600 to 1800) by 6 mammal observers. Each observer worked in 2-hour rotations, manning each of the following 3 stations on the flying bridge for 40 minutes: a port side 25x150 binocular station, a center line data recorder position, and a starboard 25x150 binocular station.

1.1.1 Logging of Data - A log of observation conditions, watch effort, sightings, and other required information were entered into a computer, hooked up to the ship's Global Positioning System (GPS - for course, speed and position information) and Scientific Computing System (SCS - for weather and heading information). An "independent observer" occasionally kept a separate watch of animals sighted during the cetacean survey operations, to be compared later with the observer team's data.

1.1.2 Breaking Trackline - On sighting a cetacean school or other feature of biological interest, the Cruise Leader or cetacean observer team on watch requested that the vessel be maneuvered to approach the school or feature for investigation. When the ship approached a school of dolphins, the observers made independent estimates of school size. Biopsy and photographic operations commenced from the bow, based on directions from the Cruise Leader or Senior Marine Mammal Observers. In some instances, the Cruise Leader requested the deployment of a small boat for biopsy, photographic or other operations (see 1.3). It was occasionally necessary to divert the ship's course from the established trackline during regular effort due to glare or adverse sea conditions. Under these circumstances, the ship was diverted up to 30 degrees from the established course. This deviation was continued until the ship was 10 nm from the trackline, at which point the ship turned back toward the trackline.

1.1.3 Resuming Effort - When the observers had completed scientific operations for the sighting, the ship resumed the same course and speed as prior to the sighting. If the pursuit of the sighting took the ship more than 10 nm from the trackline, the observers were notified. The Cruise Leader or Senior Marine Mammal Observers often requested that, rather than proceed directly toward the next waypoint, the ship take a heading of 20 degrees back toward the trackline.

1.2 Seabird Survey - Visual surveys of seabirds were conducted from the flying bridge during daylight hours by two seabird observers on a rotational watch schedule. Sighting conditions, effort, sightings, and other required information were entered into a computer interfaced with the ship's GPS (for course, speed, and position information). Seabird observers used both handheld and 25x150 binoculars.

1.3 Small Boat Work - A small boat was often necessary for biopsy sampling, photography, island surveys and marine turtle work. Deployment was requested by the Cruise Leader on an opportunistic

basis, occasionally multiple times in a single day, providing the Commanding Officer concurred that operating conditions were safe. Unless the Commanding Officer allowed otherwise, the small boat remained within sight and radio contact at all times while deployed.

1.4 Biopsy Sampling – Biopsy samples for genetic analyses of cetaceans were collected on an opportunistic basis. Necessary permits were present on the vessel. The animals to be sampled were either approached by the research vessel during normal survey operations, approached the vessel on their own, or were approached by a small boat. Samples were collected from animals within 10 m to 30 m of the bow of the vessel, using a dart fired from a crossbow or rifle. With the exception of the small boat and safety apparel, all necessary gear was furnished and deployed by the scientific party.

1.5 Photography - Photographs of cetaceans were taken on an opportunistic basis. These were used to study social behavior and movement patterns of identified individuals, and to study geographic variation. Necessary permits were present on the vessel. The animals to be photographed were either approached by the research vessel during normal survey operations, approached the vessel on their own, or were approached by a small boat. With the exception of the small boat and safety apparel, all necessary gear was furnished by the scientific party.

1.6 Marine Turtle Research - A visual survey for marine turtles was carried out by the mammal and seabird observers on the flying bridge during all daylight hours. Data were recorded in both mammal and seabird databases. Marine turtles were captured from a small boat, on an opportunistic basis, at the discretion of the Cruise Leader. Turtles were measured, weighed, tagged, and a small amount of blood was collected for genetic analysis and hormonal studies. Also at the discretion of the Cruise Leader, a stomach lavage was performed on select turtles. All turtles were subsequently released unharmed. With the exception of the small boat and safety apparel, all necessary gear was supplied and operated by the scientific party. All necessary permits were aboard the vessel.

1.7 Seabird Colony Censuses - Nesting site surveys were conducted by the scientific party at Clipperton, France; Alijos Rocks, Mexico; San Benedicto, Mexico; and Guadalupe, Mexico. On some censuses, the vessel's small boats were required for transporting observers to and from nesting sites for ground counts (on foot) of the seabird colonies. All necessary permits were aboard the vessel.

1.8 Helicopter Operations - Helicopter flight operations were required to obtain photographs for calibration of dolphin school sizes. Every day, the pilot and lead photogrammetrist met on the bridge at 0800 to discuss the plan of the day. The officer on watch was involved in the meeting and passed on appropriate information to the following watch. Flight operations were requested whenever the aerial photography team leader decided conditions were appropriate for photography, but flights mainly took place in the morning and in the afternoon, avoiding high glare conditions during mid-day. The final decision to deploy the helicopter was that of the pilot, with input from the Commanding Officer and Cruise Leader. Flight from the ship was conducted in accordance with the Shipboard Operations supplement to the NOAA-AOC Aircraft Operations Manual.

The pilot could work only six days in a row before a hard-down day was required to be declared (a flight

stand-by is equivalent to a work day) by NOAA/AOC regulations. A hard-down day was required to be declared during the 0800 meeting. When conditions changed radically, the lead photogrammetrist could request a flight and, subject to the pilot's input, the hard-down day could be canceled.

1.8.1 Pinniped Rookery Censuses - Photographic censuses of California sea lion rookeries were conducted on Islas Los Coronados, Isla Cedros, Isla Benito del Este, Isla Benito del Medio (partially photographed), Isla Colorada (a rock off Isla Cedros), and Isla Natividad, Mexico during Leg 1. During these censuses the helicopter flew a series of photographic transects over known rookery sites and surveyed the shoreline for undescribed sites that were occupied by sea lions. The ship was required to provide helicopter safety support. The Cruise Leader determined when ship time was to be allocated to these activities. Censuses were directed by the aerial photogrammetry team leader. Necessary permits were present on the vessel.

1.8.2 Aerial Photographic Seabird Censuses - The helicopter was used to conduct photographic censuses of the seabird colony on Clipperton Island (France). As in the pinniped rookery surveys, the helicopter flew transects over the islands and used the same photogrammetric methods. Censuses were directed by the aerial photogrammetry team leader. Necessary permits were present on the vessel.

1.9 Collection of Fish - Fish were collected on an opportunistic basis at the discretion of the Cruise Leader. While underway, trolling gear was used when conditions permitted. While stationary, hook-and-line gear was used. Fish were measured, sexed, and stomach contents were examined and recorded by scientific personnel. The Cruise Leader was responsible for the disposition of the catch, in accordance with NOAA Administrative Order 202-735B, dated January 9, 1989. All flyingfish specimens that landed on the decks were collected by the scientific party and frozen.

1.9.1 Collection for Food-web Isotope Project – Samples from the same fish collected under 1.9 were taken for the Food-web Isotope Project. The date, location, time of day, species, length, and sex of each fish were recorded by scientific personnel. The stomach was removed and frozen, with stomach contents intact, after being examined under 1.9. A piece of the liver and a core of white muscle was also removed and frozen. R. Olson, Inter-American Tropical Tuna Commission (IATTC), provided supplies and instructions.

1.10 Acoustics –The scientific EK-500 depth sounder was operated, at 38, 120 and 200 KHz and interfaced to a data acquisition system to estimate micronekton biomass between 0 and 500 m. The vessel's EQ-50 depth sounder was used at the discretion of the Commanding Officer, but normally remained off while underway. The ship informed the Cruise Leader of any use of the vessel's EQ-50, as it interfered with the signals received on the scientific EK-500. While in the core area (North of 5° N and East of 120°W), the scientific EK-500 was used on alternate days during the visual survey periods. Otherwise, its use was continuous or at the discretion of the Cruise Leader. The ship's ADCP ran continuously and logged to a data acquisition system. Complete system settings were provided by the oceanographer, but included 5-minute averaging of currents, AGC and 4 beam returns in 60 8-meter bins.

1.10.1 Sonobuoys - Sonobuoys were deployed periodically from either the *David Starr Jordan* or a small boat on an opportunistic basis, at the discretion of the Cruise Leader. With the

exception of the small boat, all of the necessary equipment was supplied and operated by scientific personnel.

1.10.2 Bow Hydrophone – A hydrophone mounted on the bow was activated by scientific personnel at the discretion of the Cruise Leader. All of the necessary equipment was supplied and operated by scientific personnel.

1.11 Oceanography - Oceanographic sampling was done by the oceanographer, and other designated scientists, while underway.

1.11.1 Expendable Bathythermograph (XBT) Drops – There were three XBT drops per day, at 0900, 1200 and 1500 hours local ship time, or as requested by the Cruise Leader. The XBTs were conducted and provided by scientific personnel. If the vessel stopped at the scheduled launch time, the drop was delayed until the ship was again underway. When the vessel was not going to move within half an hour, the scientist performing the drop was notified and the drop was delayed or canceled, at the discretion of the Cruise Leader.

1.11.2 Surface Water Samples – A surface water sample for chlorophyll *a* analysis and a bucket temperature was taken at 0900, 1200, 1500, and 1800 hours local ship time daily.

1.11.3 Thermosalinograph Sampling – A thermosalinograph (TSG), was used for continuous measurement of surface water temperature and salinity. A data acquisition system (WinDACS), furnished by SWFSC, was connected to the TSG output from the Sea-Bird Electronics interface box via a cable with a 9-pin female d-sub connection (provided by the ship). This computer received the raw data, with the NMEA position string attached to each record. Additionally, this computer was connected to the ship's LAN, in order to synchronize with the ship's time server. The Scientific Computing System (SCS) also collected this information. The oceanographer provided the ship's Operations Officer and Electronics Technician with detailed SCS acquisition information before departure. All SCS data were provided to the SWFSC oceanographer following each leg of the cruise.

2.0 PROCEDURES FOR NIGHT OPERATIONS

2.1 Marine Operations Log - A chronological record of oceanographic and net tow stations was kept by the ship, with dates and times in GMT. The ship provided a printed copy of the electronic marine operations log (with the cruise Weather Log and SCS data) to the SWFSC oceanographer at the completion of the cruise.

2.2 CTD Operations - The main SeaBird CTD system was provided and operated by the scientific party. The collection of oceanographic data, samples and their processing were conducted by the scientific party. The crew of the vessel operated all deck equipment and was responsible for the termination (and any necessary reterminations) of the CTD cable pigtail to the conducting cable of the winch.

2.2.1 CTD Stations - Two CTD casts were conducted each night. CTD data and seawater samples were collected using a SeaBird 9/11+ CTD with rosette (General Oceanics) and Niskin bottles

fitted with silicone tubing and o-rings (supplied by the oceanographer). All casts were to 1000 meters, with the descent rate at 30m/min for the first 100m of the cast, then 60m/min after that, including the upcast between bottles. From each cast, chlorophyll samples (to 200 m) and salinity samples (500 and 1000 m or bottom) were collected and processed on board. The 265ml chlorophyll samples were filtered onto GF/F filters, placed in 10ml of 90% acetone, refrigerated for 24 hours, and then analyzed on a Turner Designs model 10AU field fluorometer. Nutrient samples (0 - 500 m) were collected, frozen, and stored on board. Cast times were subject to change since sunrise and sunset varied during the cruise. Additional CTD stations were requested by the Cruise Leader in areas of special interest.

2.2.1.1 Pre-Daylight cast - The morning cast (1000 m) began approximately one and one-half hours prior to sunrise. This exact starting time was determined the evening before, by the Field Operations Officer (FOO). Niskin bottle water samples were collected at seven light depths and five additional standard depths, between the surface and 1000 meters. These depths were determined just prior to each cast by entering the ship's position into a computer program. Primary productivity was measured by radioactively labeled carbon uptake methods. The seven samples in bottles were spiked with ^{14}C , incubated on deck for 24 hours, filtered, and stored for later analysis at the SWFSC. The Niskin bottles (#1-7) were rinsed after each cast and acid-washed at the end of each leg. In San Diego, the oceanographers were trained by SWFSC personnel in the use of radioactivity prior to departure.

2.2.1.2 Post Effort Cast - An evening CTD cast, to 1000 meters, was conducted a minimum of one hour after sunset. The exact time was determined by the FOO. Bottle samples were collected from 12 standard depths (0, 20, 40, 60, 80, 100, 120, 140, 170, 200, 500, 1000 m). Samples for chlorophyll, nutrients and salts were taken as listed above (except the addition of four salinity samples taken from every other evening cast).

2.3 Filtering water samples - Concurrent with the evening CTD station, small samples of particulate organic matter (POM) and zooplankton were collected by the oceanographer from the ship's uncontaminated seawater system for the Food-web Isotope Project. Seawater was collected, placed in a pressurized carboy filtration system, and left for approximately an hour. For POM collection, the water was pre-filtered to remove large particles, then filtered from the carboy on to 25-mm glass fiber filters. The glass fiber filters were stored frozen. For zooplankton collection, seawater collected from the sea surface was poured over a home-made nitex filter and stored frozen. R. Olson, IATTC, provided the sampling equipment and instructions for this and other sampling for the Food-web Isotope Project.

2.4 Net Sampling: Net tows were conducted by the scientific party with the assistance of a winch operator from the vessel.

2.4.1 Dipnetting – Concurrent with the evening CTD station, dipnetting for surface fauna was conducted by scientific personnel, for one full hour, from the starboard side of the ship. This station began no sooner than one full hour after sunset. One or more deck lights were necessary to illuminate the water surface in the area of dipnet sampling. Samples were preserved, labeled, and stored in the vessel's freezer. Scientists also collected surface fauna for aquaria on board. All live organisms were donated to the Birch Aquarium upon return to San Diego.

2.4.1.1 Dipnetting for Food-web Isotope Project – Surface fauna collected under 2.4.1 were shared with the Food-web Isotope Project, at the discretion of the Cruise Leader and the scientist directing this activity. Samples were labeled and stored in the vessel's freezer.

2.4.2 Manta Tow - A surface manta net tow was conducted for fifteen minutes immediately following the post-sunset CTD station and dipnetting. Average completion time for the entire procedure was 30 minutes. The net was deployed from the starboard hydro winch. Samples were preserved in formalin, labeled, and stored in containers provided by the SWFSC until the vessel returned to San Diego.

2.4.3 Bongo Tow - An oblique Bongo tow was conducted after the Manta tow (45 minute station time), to a depth of 200 meters (wire out 300m on starboard hydro winch). Samples were preserved in formalin, labeled, and stored in containers provided by the SWFSC until the vessel returned to San Diego.

2.5 Transit - When scientific operations were complete for the night, the ship resumed course along the trackline, at a speed determined by the Cruise Leader, until it was necessary to stop for the morning (pre-daylight) CTD station.

3.0 SCIENTIFIC PERSONNEL

3.1 Chief Scientist - The Chief Scientist was Dr. Lisa T. Ballance.

3.2 Participating Scientists -

Leg 1:

Name	Position	Name	Position
Robert Pitman	Cruise Leader	Robert Pitman	Cruise Leader
Richard Rowlett	Senior Mammal Observer	Richard Rowlett	Senior Mammal Observer
Juan Carlos Salinas	Senior Mammal Observer	Juan Carlos Salinas	Senior Mammal Observer
Erin LaBrecque	Mammal Observer	Erin LaBrecque	Mammal Observer
Anne Douglas	Mammal Observer	Anne Douglas	Mammal Observer
Holly Fearnbach	Mammal Observer	Holly Fearnbach	Mammal Observer
Michael Richlen	Mammal Observer	Michael Richlen	Mammal Observer
Sophie Webb	Seabird Observer	Sophie Webb	Seabird Observer
Chris Hoefer	Seabird Observer	Chris Hoefer	Seabird Observer
Kerry Kopitsky	Oceanographer	Kerry Kopitsky	Oceanographer
Ron Dotson	Oceanographer	Ron Dotson	Oceanographer
David Demers	Pilot	David Demers	Pilot
Glen Franke	Helicopter Mechanic	Glen Franke	Helicopter Mechanic
Morgan Lynn	Photogrammetrist	Jim Gilpatrick	Photogrammetrist
Paula Olson	Photogrammetrist	Katie Cramer	Photogrammetrist

Leg 2:

Leg 3:

Name	Position	Name	Position
Lisa Ballance	Cruise Leader	Lisa Ballance	Cruise Leader
Richard Rowlett	Senior Mammal Observer	James Cotton	Senior Mammal Observer
Juan Carlos Salinas	Senior Mammal Observer	Gary Freidrichsen	Senior Mammal Observer
Erin LaBrecque	Mammal Observer	Ernesto Vazquez	Mammal Observer
Anne Douglas	Mammal Observer	Chris Cutler	Mammal Observer
Holly Fearnbach	Mammal Observer	Cornelia Oedekoven	Mammal Observer
Michael Richlen	Mammal Observer	Beth Goodwin	Mammal Observer
Sophie Webb	Seabird Observer	Sophie Webb	Seabird Observer
Chris Hoefer	Seabird Observer	Richard Pagen	Seabird Observer
Kerry Kopitsky	Oceanographer	Kerry Kopitsky	Oceanographer
Ron Dotson	Oceanographer	Ron Dotson	Oceanographer
Julie Helmers	Pilot	Julie Helmers	Pilot
Alvin Howard	Helicopter Mechanic	Alvin Howard	Helicopter Mechanic
Jim Gilpatrick	Photogrammetrist	Morgan Lynn	Photogrammetrist
Katie Cramer	Photogrammetrist	Charlie Stinchcomb	Photogrammetrist
Robert Pitman	Visiting Scientist	Robert Pitman	Visiting Scientist

Leg 4:

Leg 5:**Leg 6:**

Name	Position	Name	Position
Robert Pitman	Cruise Leader	Robert Pitman	Cruise Leader
James Cotton	Senior Mammal Observer	James Cotton	Senior Mammal Observer
Gary Freidrichsen	Senior Mammal Observer	Gary Freidrichsen	Senior Mammal Observer
Ernesto Vazquez	Mammal Observer	Ernesto Vazquez	Mammal Observer
Chris Cutler	Mammal Observer	Chris Cutler	Mammal Observer
Cornelia Oedekoven	Mammal Observer	Cornelia Oedekoven	Mammal Observer
Beth Goodwin	Mammal Observer	Beth Goodwin	Mammal Observer
Sophie Webb	Seabird Observer	Sophie Webb	Seabird Observer
Richard Pagen	Seabird Observer	Richard Pagen	Seabird Observer
Kerry Kopitsky	Oceanographer	Noelle Bowlin	Oceanographer
Dave Griffith	Oceanographer	Dave Griffith	Oceanographer
David Demers	Pilot	David Demers	Pilot
Glen Franke	Helicopter Mechanic	Glen Franke	Helicopter Mechanic
Jim Gilpatrick	Photogrammetrist	Morgan Lynn	Photogrammetrist
Charlie Stinchcomb	Photogrammetrist	Erik Eilers	Photogrammetrist

4.0 RESULTS

The following summarize the area surveyed (Figure 1) and data collected:

Table 1: Cetacean sightings

Table 2: Seabird sightings

Table 3: Marine turtle sightings

Table 4: Marine turtle samples

Table 5: Dipnet samples

Table 6: Cetacean biopsy samples

Table 7: Photogrammetry effort and photographs

Table 8: 35mm and digital photography

Table 9: Acoustic recordings

Table 10: Cetacean behavior

Table 11: Environmental data

5.0 DISPOSITION OF DATA:

All data are currently being analyzed. The final data reports will be completed by February 2005.

Marine mammal data were delivered to the Dr. Tim Gerrodette, SWFSC for analysis and distribution.

Passive acoustic data were delivered to Dr. Jay Barlow, SWFSC for analysis and distribution.

Acoustic backscatter data were delivered to Dr. David Demer, SWFSC for analysis and distribution.

Oceanographic data were delivered to Dr. Paul Fiedler, SWFSC for analysis and distribution.

Biopsy samples were delivered to Dr. Barbara Taylor, SWFSC for analysis and distribution.

Aerial photogrammetry data were delivered to Wayne Perryman, SWFSC for analysis and distribution.

Ecosystem (seabirds, turtles, net samples) data were delivered to the Chief Scientist, Dr. Lisa T. Ballance, SWFSC for analysis and distribution.


Prepared by:


LTJG Jason Appler
Survey Coordinator, STAR 2003

Date:

4-15-2004

Prepared by:


Dr. Lisa T. Ballance
Chief Scientist, STAR 2003

Date:

4/15/2004

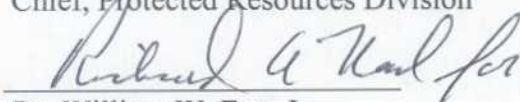
Approved by:


Dr. Stephen B. Reilly
Chief, Protected Resources Division

Date

4/15/04

Approved by:


Dr. William W. Fox, Jr.
Director, Southwest Fisheries Science Center

Date

4/15/04

Figure1: Trackline surveyed during daylight hours aboard *David Starr Jordan* during STAR 2003.

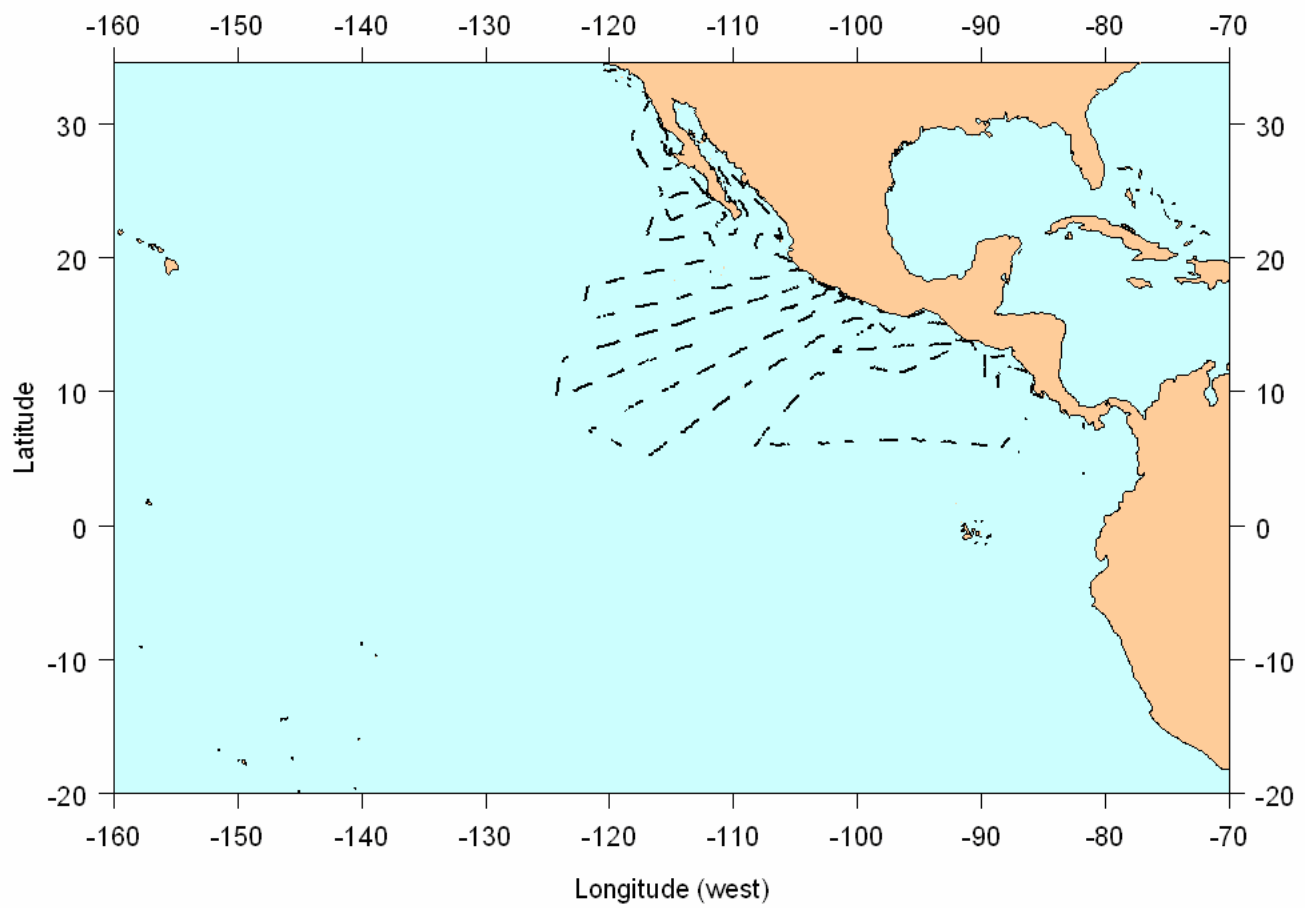


Table 1:

Summary of cetacean sightings during STAR 2003 aboard *David Starr Jordan*.

Species or Taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
<i>Tursiops truncatus</i>	32	6	30	6	17	5	96
<i>Stenella attenuata</i> (offshore)	19	14	7	16	31	7	94
unid. dolphin	3	7	6	17	23	15	71
<i>Stenella longirostris orientalis</i>	8	15	7	9	20	2	61
<i>Stenella coeruleoalba</i>	13	17	7	4	8	9	58
<i>Stenella attenuata graffmani</i>	2	5	27		23		57
<i>Delphinus delphis</i>	11	6	7		8	7	39
<i>Steno bredanensis</i>	5	9	8	5	7	2	36
<i>Grampus griseus</i>	11	4	1	3	12	1	32
<i>Balaenoptera edeni</i>	19	2	2	2		4	29
unid. small delphinid	10	8	9				27
<i>Stenella attenuata</i> (unid. subsp.)	2	1	3		6	14	26
<i>Balaenoptera musculus</i>	19		2			4	25
<i>Balaenoptera</i> sp.	12				4	2	18
unid. medium delphinid	6	2	9				17
<i>Mesoplodon</i> sp.	5	3	1		6	1	16
<i>Kogia sima</i>	6	3		1	4		14
<i>Ziphius cavirostris</i>	2	4	3	2	3		14
<i>Balaenoptera borealis/edeni</i>	4	2		2	2	3	13
<i>Globicephala macrorhynchus</i>	1			6	2	2	11
<i>Delphinus capensis</i>	9						9
Ziphiid whale	3	1	1		4		9
<i>Orcinus orca</i>	4	1	1	1	1		8
unid. cetacean	1	3	1		2	1	8
unid. large whale	3	1				2	6
<i>Stenella longirostris</i> (unid. subsp.)		2	2	1			5
<i>Lagenorhynchus obliquidens</i>	2					2	4
<i>Balaenoptera physalus</i>	4						4
<i>Mesoplodon</i> sp. A	1	1	1		1		4
<i>Delphinus</i> sp.	3						3
<i>Physeter macrocephalus</i>	1				1	1	3
<i>Stenella longirostris</i> (Tres Marias)	3						3
<i>Stenella longirostris</i> (whitebelly)				2			2
<i>Kogia</i> sp.		1			1		2
<i>Stenella longirostris centroamericana</i>			2				2
<i>Stenella longirostris</i> (southwestern)				1	1		2
unid. large delphinid		1		1			2
<i>Peponocephala electra</i>				1			1
<i>Pseudorca crassidens</i>		1					1
<i>Berardius bairdii</i>	1						1
<i>Balaenoptera acutorostrata</i>	1						1
unid. small whale		1					1
unid. whale					1		1
Total	226	121	137	80	188	84	836

Table 2:
Seabirds sighted during STAR 2003 aboard *David Starr Jordan*.

Common name	Scientific name	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Albatrosses	Diomedidae	3	0	0	0	0	31	34
Shearwaters	<i>Puffinus</i> spp.	2551	174	270	248	257	132	3632
Petrels	<i>Pterodroma</i> spp., <i>Fulmarus</i> spp.	282	526	236	718	447	92	2301
Skuas	Catharactidae	1	0	2	2	1	0	6
Cormorants	Phalacrocoracidae	4	0	0	0	0	0	4
Storm-petrels	Oceanitidae	902	88	346	368	609	296	2609
Tropicbirds	Phaethontidae	13	13	11	11	28	29	105
Boobies	Sulidae	332	278	204	410	726	302	2252
Frigatebirds	Fregatidae	46	1	11	28	23	31	140
Phalaropes	Phalaropodidae	1530	53	97	102	773	161	2716
Jaegers	Stercorariidae	4	8	20	15	68	9	124
Gulls	<i>Larus</i> spp.	176	3	5	5	31	199	419
Terns	<i>Sterna</i> spp., <i>Gygis</i> sp., <i>Chlidonias</i> spp., <i>Anous</i> spp.	235	103	95	186	369	455	1443
Auks	Alcidae	72	0	0	0	0	73	145
	Total	6151	1247	1297	2093	3332	1810	15930

Table 3:
Summary of marine turtle sightings during STAR 2003 aboard *David Starr Jordan*.

Species/Taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
<i>Caretta Caretta</i>	6					10	16
<i>Chelonia mydas</i>	1						1
<i>Dermochelys coriacea</i>		1					1
<i>Lepidochelys olivacea</i>	82	106	354	19	166	9	736
Unidentified hardshell	67	26	24	7	822	9	955
Unidentified turtle				2			2
Total	156	133	378	28	988	28	1711

Table 4:

Marine turtle samples collected during STAR 2003 aboard *David Starr Jordan*.

Species	Sample type	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
<i>Caretta caretta</i>	Biopsy						4	4
	Flipper tag						6	6
	Total captured						6	6
<i>Lepidochelys olivacea</i>	Biopsy	28	25	49	10	47		131
	Blood	28	23	44	9	41		117
	Feces					1		1
	Flipper tag	28	26	50	10	45		159
	Lavage	4	2	8	1	2		13
	Total captured	31	26	52	10	48		167

Table 5:

Dipnet samples collected during STAR 2003 aboard *David Starr Jordan*.

	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
no. stations	16	16	13	16	21	15	97
no. fish	475	360	416	481	570	287	2589

Table 6:

Cetacean biopsy samples collected during STAR 2003 aboard *David Starr Jordan*.

Species	Skin	Blubber
<i>Balaenoptera edeni</i>	11	10
<i>Balaenoptera musculus</i>	10	7
<i>Berardius bairdii</i>	0	0
<i>Delphinus</i> sp.	1	0
<i>Delphinus capensis</i>	27	15
<i>Delphinus delphis</i>	8	6
<i>Globicephala macrorhynchus</i>	6	4
<i>Grampus griseus</i>	17	14
<i>Lagenorhynchus obliquidens</i>	2	2
<i>Orcinus orca</i>	27	24
<i>Pseudorca crassidens</i>	7	7
<i>Stenella attenuata</i>	61	57
<i>Stenella attenuata graffmani</i>	56	54
<i>Stenella longirostris orientalis</i>	35	31
<i>Stenella coeruleoalba</i>	6	6
<i>Stenella longirostris centroamericana</i>	7	7
<i>Stenella attenuata</i> subsp.	11	11
<i>Stenella longirostris</i> subsp.	24	23
<i>Stenella orientalis/centroamericana</i>	12	10
<i>Steno bredanensis</i>	13	10
<i>Tursiops truncatus</i>	77	73
Total	418	371

Table 7a:
Photogrammetry effort for STAR 2003.

Leg	Days Flown	% Days Flown	Flight Hours	Average Flt Hrs per Day Flown
1	11	69%	28.6	2.60
2	7	39%	19.7	2.81
3	4	31%	16.4	4.10
4	3	18%	15.2	5.07
5	10	48%	24.7	2.47
6	9	50%	22.3	2.48
Total	44	43%	126.9	2.88

Table 7b:
Schools photographed by the aerial photogrammetry team by species during STAR 2003.

Species	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Totals
<i>S. attenuata</i>	5	7	4	0	3	1	20
<i>S. longirostris</i>	2	0	1	1	0	0	4
<i>Mixed schools: S. attenuata and longirostris</i>	4	2	0	3	2	0	11
<i>S. coerulealba</i>	4	6	4	0	1	4	19
<i>Delphinus sp.</i>	3	1	0	0	3	6	13
Other Small Cetaceans	7	6	5	6	3	4	31
Unid. Small Cetaceans	3	1	0	0	0	0	4
Small Cetacean Leg Totals	28	23	14	10	12	15	102
Large Whales	14	0	1	0	0	0	15
Beaked Whales	1	1	0	2	1	0	5
Total Sightings Photographed = 122							

Table 8:

Total photographs of cetacean schools/individuals (35mm and digital) obtained during STAR 2003 aboard *David Starr Jordan*.

Species/Stock	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6
<i>Delphinus capensis</i>	10	0	0	0	0	0
<i>Lagenorhynchus obliquidens</i>	1	0	0	0	0	0
<i>Balaenoptera physalus</i>	3	0	0	0	0	0
<i>Balaenoptera musculus</i>	18	0	1	0	0	3
<i>Globicephala macrorhynchus</i>	1	0	0	3	0	2
<i>Balaenoptera edeni</i>	8	3	1	2	0	3
<i>Delphinus delphis</i>	3	5	7	0	6	5
<i>Orcinus orca</i>	4	0	2	0	1	0
<i>Berardius bairdii</i>	1	0	0	0	0	0
<i>Stenella attenuata (attenuata)</i>	4	4	1	2	5	2
<i>Stenella attenuata (offshore)</i>	2	2	6	3	4	1
<i>Grampus griseus</i>	2	1	0	1	5	0
<i>Tursiops truncatus</i>	1	8	17	2	7	3
<i>Stenella attenuata (coastal)</i>	1	0	0	0	0	0
<i>Tres Marias spinners</i>	3	0	0	0	0	0
<i>Stenella longirostris (eastern)</i>	2	11	0	3	2	1
<i>Stenella attenuata (unid)</i>	1	0	1	0	5	0
<i>Steno bredanensis</i>	3	5	4	2	0	0
<i>Pseudorca crassidens</i>	0	2	0	0	0	0
<i>Stenella coeruleoalba</i>	0	5	7	1	0	3
<i>Mesoplodon sp.</i>	0	1	0	0	1	0
<i>Stenella longirostris (unid)</i>	2	2	0	0	0	0
<i>Stenella attenuata graffmani (coastal)</i>	0	2	14	0	12	0
<i>Balaenoptera borealis</i>	0	1	0	1	0	0
<i>Stenella longirostris (central americanus)</i>	0	0	4	0	0	0
<i>Stenella longirostris (orientalis)</i>	0	2	4	0	0	0
<i>Ziphius sp.</i>	0	0	1	0	0	0
<i>Balaenoptera borealis edeni</i>	0	0	0	1	0	1
<i>Pepanocephala electra</i>	0	0	0	1	0	0
<i>Physeter macrocephalus</i>	0	0	0	0	1	0

Table 9a:

Number of cetacean schools recorded using a bow hydrophone on *David Starr Jordan* during STAR 2003.

Species	Recordings
<i>S. attenuata, S. longirostris</i>	12
<i>T. truncatus</i>	11
<i>S. attenuata</i>	11
<i>D. delphis</i>	8
<i>S. longirostris</i>	7
<i>S. bredanensis</i>	5
<i>O. orca</i>	5
<i>S. attenuata, T. truncatus</i>	2
<i>P. crassidens</i>	1
<i>L. obliquidens</i>	1
<i>Globicephala</i> sp.	1
<i>G. griseus, T. truncatus</i>	1
<i>G. griseus</i>	1
<i>B. bairdii</i>	1
Total	67

Table 9b:

Number of cetacean schools recorded with sonobuoys on *David Starr Jordan* during STAR 2003.

Species	Recordings
<i>B. musculus</i>	3
<i>O. orca</i>	2
<i>B. edeni/borealis</i>	1
<i>B. edeni</i>	1
Total	7

Table 10:

Number of cetacean schools with behavioral data collected during STAR 2003 aboard *David Starr Jordan*.

Species	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
<i>Stenella attenuata</i> (offshore)	8	30	22	11	12	11	94
<i>Tursiops truncatus</i>	22	6	28	21	8	7	92
<i>Stenella coeruleoalba</i>	9	19	4	20	14	12	78
<i>Stenella longirostris orientalis</i>	10	13	14	8	8	5	58
<i>Delphinus delphis</i>	22		1	10	7	6	46
<i>Stenella attenuata</i> (unid. subsp.)	12	9	6	6	1		34
<i>Stenella attenuata graffmani</i>			12	16	2		30
<i>Steno bredanensis</i>	2	7		3	10	1	23
<i>Stenella longirostris</i> (unid. subsp.)	1		2			2	5
Unidentified dolphin or porpoise		2	2		1		5
<i>Grampus griseus</i>				3	1		4
<i>Stenella longirostris</i> (whitebelly)		1			1	1	3
<i>Pseudorca crassidens</i>					3		3
<i>Delphinus</i> sp.	2						2
<i>Delphinus capensis</i>	2						2
<i>Globicephala macrorhynchus</i>				1			1
<i>Megaptera novaeangliae</i>				1			1
<i>Stenella longirostris</i> (southwestern)			1				1
Total	90	87	92	100	68	45	482

Table 11:

Summary of environmental data collected during STAR 2003 aboard *David Starr Jordan*.

	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Totals
CTD casts	31	34	25	32	41	33	196
CTD chlorophyll samples	292	340	217	299	390	330	1868
Surface chlorophyll samples	54	66	45	62	89	60	376
Primary productivity samples	98	105	70	98	119	111	601
Nutrient samples	319	362	236	329	417	362	2025
Salinity samples	86	106	55	100	143	128	618
XBT drops	46	53	35	49	60	45	288
Manta Tows	16	13	8	16	14	15	82
Bongo Tows	16	13	11	16	14	15	85